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#### Recommended Citation

Hayes, S; Taylor, R; and Patterson, A, "Forensic facial approximation: an overview of current methods used at the Victorian Institute of Forensic Medicine/Victoria Police Criminal Identification Squad" (2005).

*Faculty of Science, Medicine and Health - Papers: part A*. 419.

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# Forensic facial approximation: an overview of current methods used at the Victorian Institute of Forensic Medicine/Victoria Police Criminal Identification Squad

## Abstract

Forensic facial approximation involves building a likeness of the head and face on the skull of an unidentified individual, with the aim that public broadcast of the likeness will trigger recognition in those who knew the person in life. This paper presents an overview of the collaborative practice between Ronn Taylor (Forensic Sculptor to the Victorian Institute of Forensic Medicine) and Detective Sergeant Adrian Paterson (Victoria Police Criminal Identification Squad). This collaboration involves clay modelling to determine an approximation of the person's head shape and feature location, with surface texture and more speculative elements being rendered digitally onto an image of the model. The advantages of this approach are that through clay modelling anatomical contouring is present, digital enhancement resolves some of the problems of visual perception of a representation, such as edge and shape determination, and the approximation can be easily modified as and when new information is received.

## Keywords

approximation, overview, current, methods, used, victorian, institute, medicine, victoria, forensic, police, facial, criminal, identification, squad

## Disciplines

Medicine and Health Sciences | Social and Behavioral Sciences

## Publication Details

Hayes, S., Taylor, R. & Patterson, A. (2005). Forensic facial approximation: an overview of current methods used at the Victorian Institute of Forensic Medicine/Victoria Police Criminal Identification Squad. *Journal of Forensic Odonto-Stomatology*, 23 (2), 45-50.

# FORENSIC FACIAL APPROXIMATION: AN OVERVIEW OF CURRENT METHODS USED AT THE VICTORIAN INSTITUTE OF FORENSIC MEDICINE/VICTORIA POLICE CRIMINAL IDENTIFICATION SQUAD

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## ABSTRACT

Forensic facial approximation involves building a likeness of the head and face on the skull of an unidentified individual, with the aim that public broadcast of the likeness will trigger recognition in those who knew the person in life. This paper presents an overview of the collaborative practice between Ronn Taylor (Forensic Sculptor to the Victorian Institute of Forensic Medicine) and Detective Sergeant Adrian Paterson (Victoria Police Criminal Identification Squad). This collaboration involves clay modelling to determine an approximation of the person's head shape and feature location, with surface texture and more speculative elements being rendered digitally onto an image of the model. The advantages of this approach are that through clay modelling anatomical contouring is present, digital enhancement resolves some of the problems of visual perception of a representation, such as edge and shape determination, and the approximation can be easily modified as and when new information is received.

(J Forensic Odontostomatol 2005;23:45-50)

**Key words:** Forensic facial approximation, face perception, facial recognition, forensic facial reconstruction, forensic art

## INTRODUCTION

Forensic facial approximation involves approximating the appearance of an unknown individual in order to establish both the legal requirement and social right to identity. In Western countries 0.1% of deaths cannot be readily identified,<sup>1</sup> and therefore a facial approximation may be performed. Melbourne University and the Victorian Institute of Forensic Medicine prefers the term 'facial approximation' over the more popular 'facial reconstruction', given that the aim is to produce a likeness. That is, no aspect involved in the process can be regarded as

absolute; recommendations for modelling the head and face are built upon reasonable assumptions drawn from statistical averages of human variation, and are therefore approximate.<sup>2-4</sup> In order to achieve identification, an image of the approximation is broadcast in the media to stimulate recognition in the minds of those who knew the person in life. Those whose memories are triggered by the approximation may be family, friends or colleagues, but some leads to identification have been provided by more casual acquaintances.<sup>5</sup>

Many forensic facial approximations are either manual (clay modelling) or virtual (computer graphic simulation), with the focus of much recent research being on the virtual. Virtual approximations typically involve scanning the skull, producing a wire-frame image, and then applying soft-tissue depths at appropriate points to produce a representation of a face. As clay modelling requires anatomical knowledge, sculptural ability, experience and time, it is hoped that a virtual approximation will both simplify the process and be faster.<sup>6</sup> However, to date virtual methods tend not to allow for the contouring of facial anatomy, being dependent on a limited set of craniofacial points, although this data set is expanding.<sup>7,8</sup>

Since 1990 the Forensic Sculptor to the Victorian Institute of Forensic Medicine (VIFM) has collaborated with the Victoria Police Criminal Identification Squad, which has resulted in a method which utilises the advantages of both clay modelling and computer graphics. That is, modelling is used to determine an approximation of the person's head shape, anatomical contouring and feature location, and computer graphics to enhance edge and shape definition and add more speculative elements, such as hair style. Although the generation of leads through public

broadcast is dependent on the timing and extent of media coverage,<sup>3,5</sup> to date this collaboration has involved eight cases, contributing to two successful identifications.

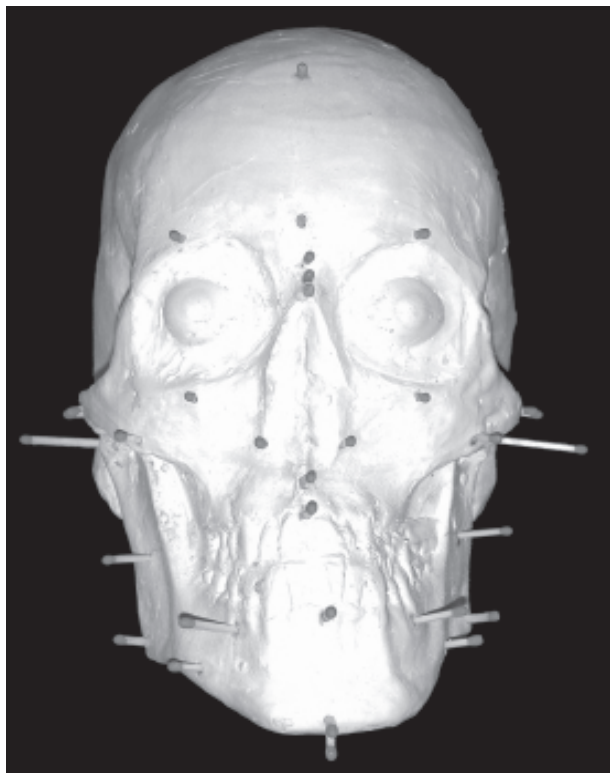
### Modelling

The clay modelling phase of the approximation occurs in a team environment, drawing on a range of forensic specialisations, including, but not limited to, forensic pathologists, odontologists, anthropologists and crime scene investigators.<sup>1</sup> The skull and post-cranial remains are examined to suggest the most likely population of origin, sex and age,<sup>9</sup> and if present, evidence from the scene can also suggest body weight, hair shape and colour. While some forensic sculptors prefer to work directly onto the original skull,<sup>10</sup> use of a plaster cast for the facial approximation reduces the risk of damage to the original skull and ensures that the original is available for reference during the approximation process. Due to the method used, the completed cast retains important information about muscle attachments and bony landmarks that assist in the reconstruction process.<sup>11</sup>

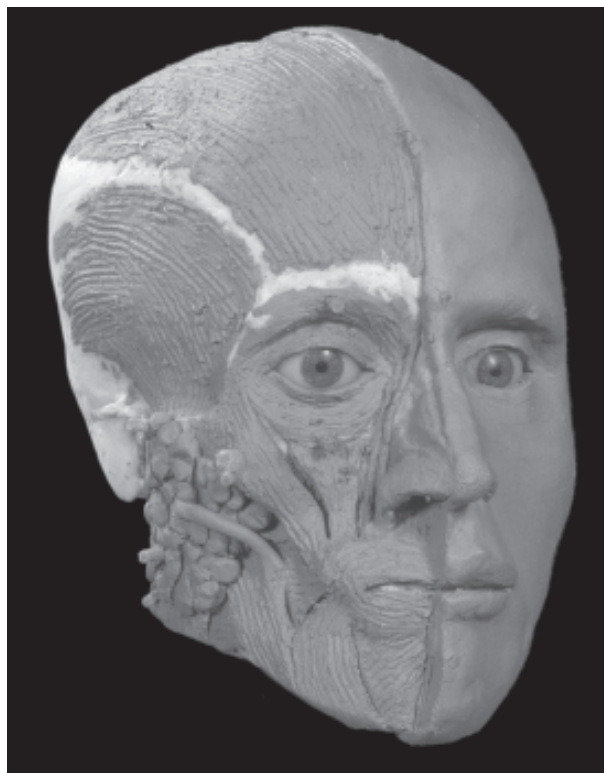
In order to build the anatomy of the face upon the skull, modelling incorporates soft-tissue depth data.

That is, statistical averages of soft-tissue depths at specific craniometric points, taken from living individuals through the use of ultrasound.<sup>5,12</sup> Soft-tissue depths are applied to the skull by the use of pegs, which involves drilling holes in the plaster cast of the skull at 19 craniometric points, and inserting the pegs to the length indicated (Fig.1). As Brown *et al* point out, no standard set of craniometric points currently exist,<sup>13</sup> but the VIFM modelling method uses Helmer's ultrasound data set as this includes variation according to the approximated age, sex and body weight of the person.<sup>14</sup>

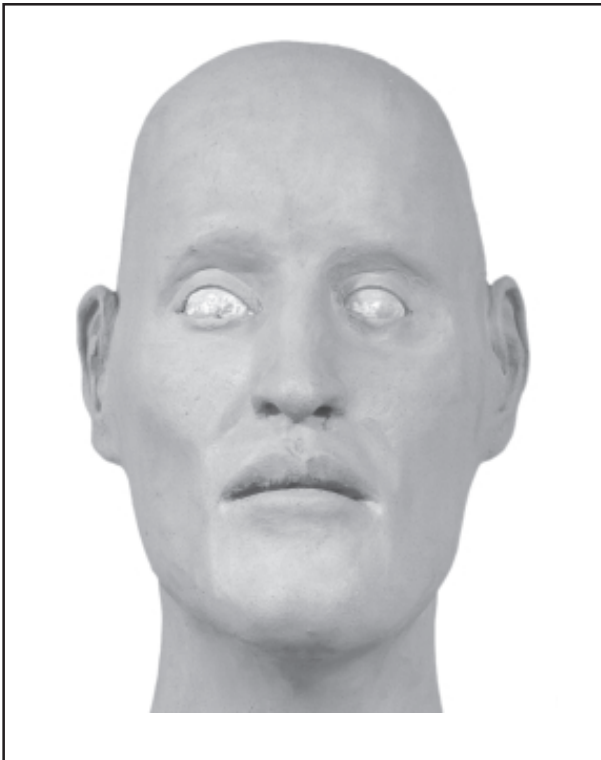
Once the pegs are in place, the soft-tissues of muscles, glands, fat and skin are built up as individual components in a stylised, yet systematic fashion, and the tissue depth pegs are used as general indicators (Fig.2). Overall head shape is largely determined by the morphology of the cranium and mandible, and the bulk of the temporalis and masseter, with muscle position and strength being indicated by attachment markings on the skull.<sup>5,12,15</sup> Research by Wilkinson, and Stephan, has resulted in guidelines for approximating nose projection and pronasale position,<sup>12,16</sup> mouth width,<sup>12,17</sup> eyeball placement and projection.<sup>12,18</sup> Fedosyutkin and Nainys



**Fig.1:** Plaster cast of skull with soft-tissue depth pegs



**Fig.2:** Anatomical modelling of soft-tissues

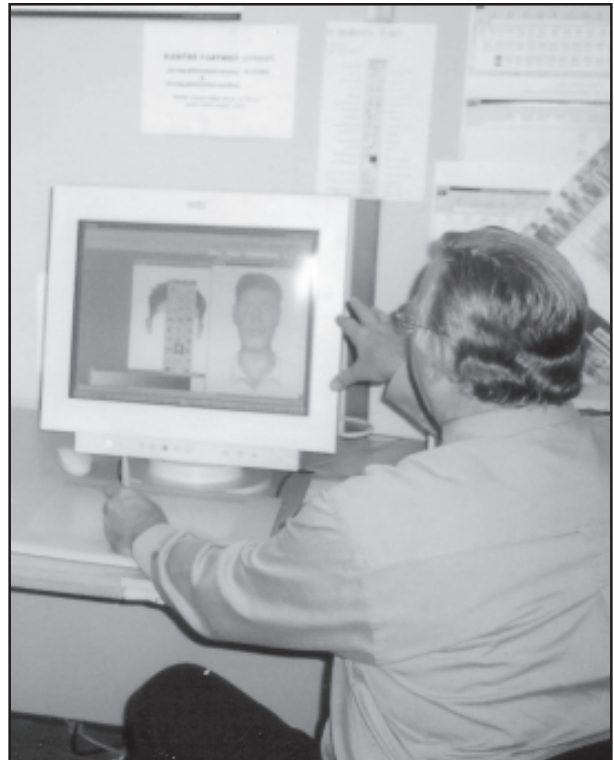


**Fig.3:** Base-line model

provide approximate morphological relationships for the location and length of the eye slit and brow shape,<sup>15</sup> while lip thickness can be inferred from dental occlusion patterns,<sup>12,19</sup> and ear location from the position of the external auditory meatus.<sup>12</sup>

What cannot be approximated from the morphology of the skull alone includes hair style and colour, eye colour, skin colouration and texture, nose and ear shape, and the lines and folds of the skin,<sup>12,15</sup> though Neave<sup>20</sup> has developed a series of typical age-related changes in an adult face.

In keeping with the need for the most accurate approximation based on the morphology of the skull, the method for modelling utilises an unembellished style. That is, the technique allows facial shape to predominate and feature location (eyes, mouth, nose) to be clearly seen (Fig.3). The desired outcome at this stage of the process is to produce a forensically defensible base-line model. This is not, however, the final appearance of the approximation. Research suggests that face perception and recognition requires the addition of surface appearance and some speculative detail,<sup>12,21</sup> particularly when viewing a representation, or likeness, of a face.



**Fig.4:** CIS image database

### Graphics

Recognition research suggests that memory for faces is primarily triggered by the overall shape of the head and face and the spatial relations between the features.<sup>22</sup> The identification of strangers is more reliant upon the external aspects of face shape and hair style, while recognition of familiar faces tends to focus on internal features,<sup>21</sup> with the eyes taking precedence over the mouth, and the nose being less important.<sup>12</sup> With the exception of hair style, accurately approximated clay modelling complies with these requirements for recognition, providing overall head and face shape and featural location. However, face perception requires further information concerning texture and indications of depth and form,<sup>12,21</sup> elements which are often obscured by, or absent from, approximations of the face. Using the skills and technology of the Victoria Police Criminal Identification Squad (VPCIS) these elements are added digitally to the model.

Once the modelling stage of the approximation is complete, a digital image is taken under neutral lighting. The resulting file is loaded into the VPCIS graphics programme, and the Facial Automated Composition and Editing (FACE) database accessed



(Fig.4). FACE was initially developed in Victoria in 1986, and currently comprises an extensive database of facial components according to population of origin, sex and age.<sup>23</sup>

The first stage of the digital approximation process is to select an appropriate flesh tone according to the deceased's population of origin. Hair colour and texture is then selected, drawing from the database a close match to any hair that may have been found by the forensic team. If no hair is available, the tone used to render the hair is darker than that used to show skin, but not overly so. A mid-dark tone with highlights used to indicate external light enables multiple readings of 'colour', even light coloured hair.<sup>10</sup> The style of the hair depends on the age and sex of the deceased, and the year that death occurred, and is modified to 'fit' the shape of the cranium, which Fedosyutkin and Nainys suggest influences hair style.<sup>15</sup> However, as hair style and head shape constitute key requirements for recognition,<sup>21</sup> care is taken to ensure the hair style, which is speculative, does not detract from the overall head shape provided by the clay model.

Eyebrows are matched in colour and texture to the hair, and applied. While the supraorbital ridge and superciliary arches can suggest brow shape,<sup>15</sup> thickness is speculative, and therefore the rendering is unobtrusive.

Despite featural location, and to an extent, shape, being clearly indicated on the model, one effect of clay, even with a flesh tint overlay, is to produce a monotone. Monotone has the visual effect of diffusing edge boundaries, making shape discrimination difficult and reducing the ability to recognise a familiar face.<sup>12,21</sup> Using a graphics tablet, the next stage is to emphasise the edge and shape information available on the model. Lash lines are drawn in to more clearly indicate the eye slit, and the pupil and iris blocked in. Colour of the iris will be dictated by population of origin; for Caucasians a hazel iris is recommended as it is visually inclusive of a fairly wide range of possibilities.<sup>10</sup> Shading and highlights are used to show the vermilion line, lip tonal density, and to subtly emphasise the nasal wings and pronasale. As with most forensic art the light source used to add highlights, general facial contouring and plane shifts (such as temple to forehead) is multidirectional, to ensure all features are given equal visibility.<sup>10</sup> Dramatic lighting, where part of the face is given greater visual weight, can radically alter appearance and there is evidence that this disrupts facial recognition.<sup>24</sup>

Because face perception and facial recognition require both edge and shape information, the best angle to present the face is three-quarter profile, similar to that utilised by portrait artists.<sup>21</sup> Most forensic images of the face, as with standard identification images, are full face,<sup>10</sup> which perception research suggests is the hardest to see. What is most obscured by a full face view, however, is the shape of the nose.<sup>21</sup> However, determination of the nose from the morphology of the skull can only suggest the likelihood of nose projection and placement of the pronasale;<sup>16</sup> the finer details of shape are more speculative. Therefore, as edge and shape information is generally clarified through shading, and ambiguity concerning nose shape more accurately represents what can be approximated, a full face view is more advantageous. Further, recognition research indicates the three-quarter view only really benefits memory of a previously unfamiliar face, with familiar face recognition being not as view dependent.<sup>21</sup>

The overall graphic style utilised for adding textual elements is smoothly blended, which as well as being unobtrusive, has the added advantage of reducing pixelations formed during the digital process (Fig.5). Although it is possible to produce an image with a simulation of a photographic finish, such an effect implies specificity, not approximation,<sup>10</sup> and may mislead the viewer. In addition, according to



**Fig.5:** Completed facial approximation for broadcast

visual processing research, vision is an active process, both enhancing and interpreting what is received and drawing on past experiences and expectations in order to 'see'.<sup>21</sup> To enable this active process, which is necessary for face perception to take place, a represented face (as opposed to 'real') requires areas of less definition, of ambiguity; areas that can be filled in by the individual.<sup>25</sup>

Although the final image can be printed in colour, for forensic facial approximations the preference is for greyscale. This is because greyscale allows for multiple readings of skin, hair and eye colour;<sup>10,21</sup> information that cannot be determined from the skull alone. If the evidence gathered by the forensic team suggests a range of possibilities regarding body weight and hair style then the approximation may be reworked and alternatives produced, allowing for differences in the fullness of the face, length of hair, the presence of facial hair, and so forth. The purpose of the final approximation is to evoke recognition, not prove identity, and variations in the more speculative elements of the deceased's appearance are used, when required, to further stimulate public interest and input.

## CONCLUSION

The VIFM/VPCIS method of forensic facial approximation works within both the known parameters of clay modelling upon the skull and the visual requirements for perception and recognition of a represented face. Following skull replication and insertion of appropriate soft-tissue data guidelines, clay modelling is used to establish an approximation which clearly displays head and face shape, anatomical contouring and feature location. The VPCIS image database and graphics program is then used to overlay more speculative elements, such as hair style and texture, and a graphics tablet is used to add perceptual information concerning shape and edge definition. Where there is confidence concerning the likely appearance of a particular facial feature, such as head shape and feature location, these elements are emphasized, with less detail going to the more indeterminate aspects. A benefit of this method is that the digital image can be easily modified should subsequent forensic examination alter the initial findings, or when new leads concerning the possible identity of the deceased are received.

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